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HUMAN CAPITAL AND OTHER FACTORS OF THE TOTAL PRODUCTIVITY IN SPANISH REGIONS

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ABSTRACT

The productivity evolution results a main factors indicators in order to explain the uneven growth of the different economic spaces and their different levels of welfare in a long run.

Just, the crucial importance of productivity for economic growth can be derived from its relation to other indicators of economic performance. Among other factors, these include accumulation of physical and human capital, technological progress, resources allocation and efficiency, and competitiveness.

For this reason, in this paper we elaborate in the first place an indicator of Total Factor Productivity for the Spain regions from of point of view of the theoretical justifications of the different methodological proposals.

In the second place, and using the available statistics, we explain the unequal behaviour of the Total Factor Productivity (TFP) between these regions from a point of view that variables like public capital (infrastructure), human capital (qualification), technological capital (research and development), productive specialization, the different grades of resource's uses, the exploitation of scale economies ..., may justify the regional divergence in productivity terms.

1.-INTRODUCTION

The concept of productivity is usually used to indicate a ratio, the relation to the quantity of obtained output and the volume of one or more inputs used for the output. The evolution of that ratio is very important in order to know the economic "health" of an Economy, sector or industry or an enterprise, and also for evaluating their competitiveness; or the gains in well-being of the reference society, since in the long run the standard of living of a society depends on, in great part, gains in the efficiency in the use of their inputs. For all these reasons it is important to measure appropriately the behaviour of the productivity indicator.

It is difficult to find a global measure of productive factors, and thus, the partial productivity is used. In spite of that, the analyses of total productivity is more adequate for knowing the efficiency of use of the inputs for obtain the output.

In this paper, we begin by outlining the theoretical framework for Total Factor Productivity (TFP) measures. Section 3 presents the data used and the TFP indexes calculated for Spanish regions; these results show the process of convergence-divergence between the regions, in the last years, from the point of view of productive efficiency. Finally, we explain the trend of TFP using an econometric model, and report the main conclusions.

2.- PRODUCTIVITY MEASUREMENT

In order to measure productivity, we should analyse the relation of output and the productive factors, as well as the variations in output that don't imply variations in the inputs.

The first measures used for studying the evolution of productivity (and the most widely used nowadays) consists of dividing the aggregate of output between the aggregate of one input, the partial productivity indexes are:

$$PP_i = Q/F_i$$

where Q is the aggregate of output and F_i is the aggregate of input i.

This method is simple, because to it considers only one input, and it's impossible to analyse the relation to "substitution-complementarily" among the productive factors and makes it impossible to identify the responsible agents of the productivity variances: economies of scale, technology improvements, qualities in labour force,...

Because of partial productivity limits (they can collect the improvements among productive factors) the index of TFP (Total Factor Productivity), that takes into account all the inputs considered, at the same time, and of course, is a measurement more specific

$$TFP = Q/F$$

The aim of the analysis consists in studying the evolution of this ratio, the increases in the quantity of output and the quantities used of different factors are compared (by ratio or by difference) .

The three indexes of TFP most used in the economic field are: Solow, Kendrick and Divisia-Törnquist.

The differences between Solow and Kendrick indexes are in their production function. The Kendrick index is based on a linear production function –very criticized, as it assumes an infinite elasticity of substitution (Domar, 1962) and, because of that, it uses an arithmetic weighted procedure of the factor. On the other hand, Solow uses a Cobb-Douglas production function and, so that the weighted procedure of factors is geometric.

Also, the most important criticism to Solow´s residual used to measure TFP, is that only under the assumptions of constant returns to scale and competitive equilibrium is it

equal to the variation in the aggregate output not due to variation in aggregate input (just in Divisia index). For more detail , see Rodríguez (1995).

The Divisia index can be defined as a weighted average of rates of growth in which the components are weighted in proportion to their total value share, (see Rodríguez, 1995). Given that the majority of the economic data to be used are not continuous, it is necessary to adapt the Divisia index for it to be applicable to discrete data. The most commonly used approximation is the one by Törnquist (1936)and Theil (1967). So, the rate of growth of this index can be denoted as

$$\Delta TFP = \Delta \ln Q - \Delta \ln F$$

also known as the Divisia index of Total Factor Productivity, where

$$\Delta \ln Q = \ln\left[\frac{Q_t}{Q_{t-1}}\right] = 1/2\sum_j (b_{jt} + b_{jt-1}) \ln\left[\frac{q_{jt}}{q_{jt-1}}\right]$$

$$\Delta \ln F = \ln\left[\frac{F_t}{F_{t-1}}\right] = 1/2\sum_i (a_{it} + a_{it-1}) \ln\left[\frac{x_{it}}{x_{it-1}}\right]$$

Where (qjt) are outputs with prices (pj), the (xi) are inputs with prices (wi), (lnQ) is the growth rate of aggregate output, (lnF) is the growth rate of aggregate input and:

$$b_{jt} = \frac{p_{jt}q_{jt}}{\sum_j p_{jt}q_{jt}} \qquad y \qquad a_{it} = \frac{w_{it}x_{it}}{\sum_i w_{it}x_{it}}$$

are the share of each kind of output and input in the production value (bjt) and in the total cost (ait).

In this paper we use this discrete time interval index developed by Törnqvist, as it offers important properties in the analysis of total productivity, analysed by Ritcher (1966), Hulten (1973) and Diewert (1976). Besides we calculate this index as a chain index, as several authors –Ball (1985), Thirtle and Bottomley (1992)- show they are better than direct indexes because chain indexes are less sensitive to annual variations in prices.

3.-DATA AND PRODUCTIVITY RESULTS

In productivity studies we should differentiate between private and public sector of the Economy. This consideration is justified for several reasons: the function rules are not similar, they are interrelated ... etc. It is difficult to separate both sectors given the available data, however we try to quantify the private sector by removing non-sales services from the overall economy.

We report the Total Factor Productivity indexes and the econometric model (for studying its causes) over the period 1976-95, (as we do not have more homogeneous data for our series). The analysis includes the overall economy and their regions; the variables used –in the TFP index obtained- are the following:

OUTPUT: The statistics sources offer data about gross value added (GVA), as we use this variable as a production measure; Arrow (1974) shows that under conditions where factors con be separated its use is adequate. We utilized factor cost GVA (1990 prices) from Hispalink database until 1979, and from here, the data coming from Spain Regional Account.

INPUT: When the GVA is taken into account, like production, the productive factors considered are labour and capital. Arrow (1974), identifies the primary consumption function (K –capital- and L –labour-) as a function of real added value.

Capital (K): We use data of net stock of private capital from Banco Bilbao Vizcaya Foundation (2000).

Labour (L): We should measure labour force by worked hours, but no data are available, thus, we use the number of workers in the different regions. Source data are EPA (Encuesta de Población Activa. Spain Statistic National Institute, INE).

Share Factors: It is approached by their participation in factor cost.

As argued before, a Divisia-Törnqvist index was chosen. Table 1 reports the annual average growth rates by period (1976-95) for the Total Factor Productivity (TFP), the ratio GVA/L and GVA/K.

Table 1

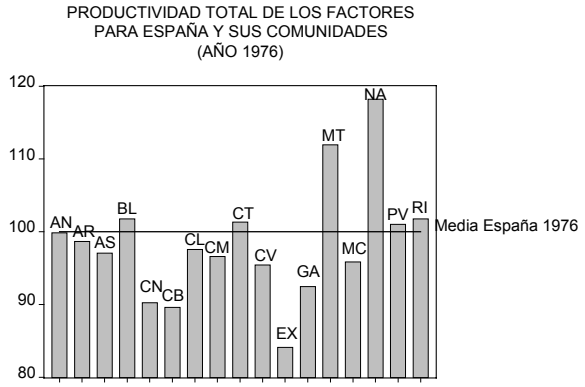
Annual average growth rates (%) by period, 1976-95.

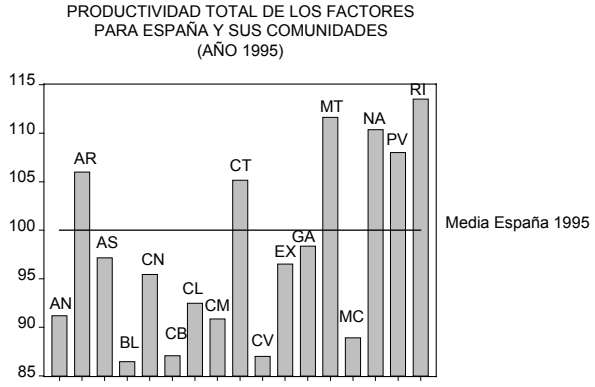
	VAB/L	VAB/K	PTF
Andalucía	1.614997	-1.393889	0.009936
Aragón	2.489920	-0.534349	0.868973
Asturias	1.869569	-0.993872	0.493768
Baleares	1.174921	-1.282137	-0.369847
Canarias	2.149855	-0.280647	0.784640
Cantabria	1.521622	-0.554972	0.336182
Castilla y León	2.289790	-1.306336	0.204739
Castilla-La Mancha	2.515864	-1.530772	0.164939
Cataluña	1.708069	-0.534423	0.685269
Com. Valenciana	1.599406	-1.421724	3.81E-05
Extremadura	3.844231	-0.570451	1.218891
Galicia	2.985326	-1.021056	0.816306
Madrid	1.518254	-0.728592	0.473769
Murcia	1.902279	-1.219379	0.090889
Navarra	1.565260	-1.181328	0.125708
País Vasco	1.448469	-0.052268	0.842533
Rioja	3.402396	-0.573124	1.067235
España	1.916106	-0.923124	0.488486

What stands out in this table is that annual average growth rates of labour partial productivity in all regions (Spain 1.92%), are greater than TFP rates (Spain 0.49%). It is due to capital factor grew more in all regions than their Gross Added Value, thus the

annual average growth rate of the ratio GAV/K is negative. So, with available data of private capital stock, high growth rates of TFP cannot be obtained; if this factor is less weighted up, rates will be greater.

In the following figures it is possible to distinguish the TFP levels in the regions with regard to Spain's mean value for the years 1976 and 1995. The objective is to compare the positions of departure-arrival of the different regions in reference period. Table 1 shows the idea of relative convergence among the regions on productive efficiency terms (as explains TFP growthing speed, because regions with rates over Spain's mean value improve their relative position). From this analysis we can not see patterns of convergence, as regions like Madrid, Cataluña or La Rioja well-positioned in 1976 have grown over Spain average (Madrid grows round the mean), however other regions like Cantabria, Castilla y León or Castilla-La Mancha with low levels grow under the mean.





4.- DETERMINANTS OF THE TOTAL PRODUCTIVITY

The quantity of private sector production of a fixed economy (and of course, its productivity) depends on several variables with great significance in productive efficiency's definition; moreover the different use of productive factors.

We consider human capital effects, for Spanish regions, besides other we explain next.

-Human capital

It's assumed schooling investment (to increase the stock of human capital) has repercussions on productivity gains. Several studies about economic growth (for example, Lucas (1988), Romer (1989), Guisán, Aguayo y Expósito (1998)) demonstrate the importance of human capital in order to explain the uneven evolution of the different areas of economy, and therefore its influence on productivity growth. Martin (1997) points out human capital has double-influence on the economic growth: the knowledge of labour force has a direct influence on labour productivity, and on the other hand, has an indirect influence as improves physical and technological capital's returns.

We consider as proxy variable of human capital, both the ratio of employment with at least secondary studies (KH) and the ratio of active population with the same studies (KH1); data are from IVIE (2000).

This variable is considered in the model as multiplicative dummy (DKH, o DKH1) measures differential effect (previously contrasted) of human capital in the Spanish regions.

-Technological capital

The same case occurs for technology, numerous studies demonstrate the significant influence of technology in economic growth -see for example Romer (1990), Grossman and Helpman (1991)- . In practice -with important matizaciones?- resources destined to research and development (R&D) activities are considered like a reasonable measurement of techniques knowledge. In this paper no data available for the regions don't allow to use this indicator. An alternative we have considered is the ratio between stock of private capital and labour force (INK), as a indicator of "intensity capital use". This indicator shows aspects of techniques advances (under the idea an intensive use of capital represents productive process more mechanized and with a better technology), but includes also another effects like substitution effect between the two factors involved.

-Public capital

The stock of public capital, and more specific, the assignment of several infrastructures (highways, ports, hydraulics constructions, railways, ...) no related directly to enterprises factors assignment or different sectors, may do positive externalities on their productions, as demonstrated in Stern (1991), Munnell (1992), Argimon and other (1993), Más and other (1993) and Guisán and Cancelo (1997) among other.

As says Martin (1997) the stock of public capital influences to productivity in a dual way: in first time allows necessary equipments for enterprise's activities (high tension network, ports, motorways...), and they aren't support by private enterprise; and furthermore, better infrastructures allow to make use of scale economies, and provides an easy supply of greater markets. Definitively, it's feasible public capital have a positive impact on private sector's productivity, as infrastructures assignment may condition the establishing of different enterprises.

In our paper, we consider overall public expenditure -KPU and their annual increases (IKPU)- is the expenditure done by Public Administration (stock of public net capital); and it's considered like an approximation to infrastructure level. For that, we use functional classification of Public Administration Expenditures proposed by ONU (1980). The expenditures are classified on: highways, hydraulics infrastructures, urban structures, ports, railways, education and health and remaining of Public Administration. The data source is BBV Found, and are expressed in million of pesetas of 1990.

-Productive structure

Some recent papers -Raymond and García (1994), De la Fuente y Freire (2000) contrast the influence of sectorial structure in convergence process of Spanish regions (specially the importance of expulsion of agrarian labour force to other sectors more productive) of the different regions; and changes in it, affect in productivity levels of the regions, as productive efficiency reached in different activities and experimented changes don't be homogeneous (Pérez, Goerlich and Mas (1996)).

This authors shows agrarian and services sectors have extreme behaviour: agrarian sector own lowest productive levels, and highest growth rates in the last year, the opposite of services sector.

Taking into account this considerations, we have elaborated two main indicators of the different productive structures: ratio agrarian GVA/remaining sectors (EP), and services sector GVA/remaining sectors (EP1), in order to analyse the change in productive structure in Spanish regions.

- Other determinant factors

Other significant variables of interest whose influence has been contrasted in the determination of the total productivity are the effects of scale and the degree of utilization

of the productive factors. The statistical information available do not allow us to make adequate indicators for these effects to the Spanish regions.

Empirical specification and estimation results

We intending to make a model to explain the relations between the index of total productivity and its possible determinant factors. According to Pulido (1983), our aim is not to confirm a theory but we are trying opening or widen certain roads of investigation that seem us coherent and sure enough in the study of the behaviour of total productivity for the Spanish regions.

In a great part of the empirical studies about the total productivity and its determinants part from a function of specific production and (with very restrictive assumptions regarding the characteristics of the productive processes) they deduce a lineal specification. Because our objective is to clarify the relations between the aforementioned variables, in this study we have checked different functional specifications of the generic equation that we proposed (without a priori assumptions) :

Index of TFP = f (indicators of human capital, of public capital, of technological capital, of the productive structure, of other determinants)

To estimate this relation we have data from seventeen Spanish regions for 1976 to 1995. We could obtain consistent estimators making a regression with an equation for all the regions, if the equation coefficients to the explanatory variables for different regions were identical. In this case, it is scarcely credible for this assumption to occur because we working with substantially different economic structures units. In fact, carrying out common parametric stability test F manifest lack of stability in the model.

Even taking the prior into account and since our sample (19 observations) is small to make one regression for every region, and to take advantage of the scarce available information, we have opted to specify a sole equation for all regions. Therefore, we adopted the interpretation of Zellner (1969), in the sense that if the parameters differ

between the regions, and the divergence are random and independent of the values of the regressors, the resulting estimates are approximating average responses. That is to say, the estimate with panel data must be understood as an attempt to approximate average effects for the economic units. The estimate that we have selected is the one shown in table 2.

Regarding the estimate, we have made use of the contrast of erogeneity by Granger and by Hausman. The results are as predicted with respect to direction of the causation, though these results must be taken with precaution given the reduced temporal dimension of the panel. Precisely because of the short temporal sample we took (1976-95), it does not seem to us very significant to carry out a previous analysis of the order of integration of each one of series (the result would not be very reliable). However we have studied the residuals (modelling the first difference of the residuals in every regions in relation to the corresponding retarded residue) to screen out the presence of unitary roots in it. The high value obtained for the t statistic of the coefficient of the retarded residue (in all the cases), we may consider it as evidence in favour of the specification that we are presenting in the table 2 (see Raymond y Mauleón, 1997).

We have used the common contrasts of heterocedasticity and autocorrelation for panel data (see Greene, 1997) and the test of Hausman (1978) to contrast fixed effects as opposed to random effects. Accordingly we have chosen the estimate that we present in the table 2. The model was estimated by minimum weighted squares (of repetitive manner with fixed effects, in which we have considered the heterocedasticity between the regions) whose estimates converge with maximum likelihood estimates (Greene, 1993), and considering autocorrelation of first order.

Of the results of the estimate we emphasize the positive effect of the human capital (DKH), the public capital (IKPU), the sector structure (productive specialization, EP) and of intensity of capital (INK), although the effect of this variable is not significative (it's a variable that collects various effects, including the technological effect). Moreover, we can see that upon including the indicator of human capital (with similar results if we include the proportion of active population or of employees that have at least secondary studies) as a

multiplicative dummy eliminates the habitual correlation (very intense) existing between this indicator and the public capital indicator. On the other hand, the positive and meaningful effect of the ratio *value added of agriculture / remainder of sectors* could be interpreted as response to the strong restructuration in the agriculture sector in recent years by substitution of capital from labour, - furthermore, according to the work of Pérez, Goerlich and Mas (1996), this sector presents a greater rate of growth of total productivity and labour productivity -. On the contrary, if we include as indicator of the productive structure the ratio *value added of private services / remainder of sectors,* the effect on productivity would be negative, because service sector presents the lowest of growth in productivity in recent years.

Table 2. Results for the selected regression model.

GLS (Cross Section Weights) // Dependent Variable is PTF?// Sample: 1977 1995
Included observations: 19// Total panel observations 306
Convergence achieved after 9 iteration(s)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DKH?	0.060417	0.012090	4.997051	0.0000
EP?	0.082170	0.037109	2.214296	0.0276
INK?	0.001896	0.001434	1.322536	0.1871
IKPU?	0.044111	0.018197	2.424096	0.0160
AN--C	0.269694	0.015529	17.36699	0.0000
AR--C	0.308128	0.015233	20.22771	0.0000
AS--C	0.293112	0.015292	19.16736	0.0000
BL--C	0.287755	0.020909	13.76242	0.0000
CN--C	0.290742	0.015309	18.99188	0.0000
CB--C	0.250917	0.016970	14.78615	0.0000
CL--C	0.275763	0.015655	17.61474	0.0000
CM--C	0.253879	0.017077	14.86716	0.0000
CT--C	0.248301	0.018593	13.35475	0.0000
CV--C	0.266215	0.015924	16.71806	0.0000
EX--C	0.259847	0.018475	14.06471	0.0000
GA--C	0.276494	0.014572	18.97451	0.0000
MT--C	0.351240	0.014396	24.39846	0.0000
MC--C	0.283403	0.017662	16.04604	0.0000
NA--C	0.350426	0.015485	22.62965	0.0000
PV--C	0.303150	0.014869	20.38866	0.0000
RI--C	0.359348	0.018544	19.37850	0.0000
AR(1)	0.703242	0.040851	17.21465	0.0000

Weighted Statistics

R-squared	0.993066	Mean dependent var	0.373459
Adjusted R-squared	0.992553	S.D. dependent var	0.121745
S.E. of regression	0.010506	Sum squared resid	0.031347
Log likelihood	1371.813	F-statistic	1936.780
Durbin-Watson stat	1.746021	Prob(F-statistic)	0.000000

Unweighted Statistics

R-squared	0.902010	Mean dependent var	0.323414
Adjusted R-squared	0.894765	S.D. dependent var	0.032386
S.E. of regression	0.010506	Sum squared resid	0.031347
Durbin-Watson stat	1.815514		

Lastly, the significance of fixed coefficients indicates the important differences not explained by the explanatory variables between the regions.

5.-CONCLUSIONS

About summary and conclusions we could say the following :

-We assume that the Spanish regions that have a relatively more rapid growth, in terms of productive efficiency, are the ones that have greater probabilities of convergence in the long term, and that TFP is a good indicator of gains in efficiency in the utilization of the productive factors.

-Average rates of annual growth of total factors productivity are lower than the corresponding rate of partial labour productivity in all the regions, due to the differentiating effect of the capital input.

-Furthermore, the behaviour of the ratio *value added / capital* (in agreement with the available data), with an annual negative growth, is incompatible with high rate of growth of total productivity.

-The results obtained do not indicate clear pauses of convergence in productivity between the Spanish regions, given that the regions that begin from the lowest levels of productivity do not always grow relatively more.

-About the determinants of total productivity we emphasize that, without the possibility of putting in our model variables like indicators of capacity of utilization, indicators of scale, etc... a great part of the different evolution in productivity among the regions remains without explanation and that in great measure comes in the high value of the coefficients of fixed effects of the model. On the other hand, the public capital, human capital and productive structure manifest a positive effect on the growth of productivity, and upon including the indicator of human capital as multiplicative dummy variable we are eliminating the habitual problem of multicolineality due to the relation between human and public capital.

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